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Online databases:WPI,CLAIMS

(54) Etching thin coatings

(57) In apparatus for etching thin coatings, preferably indium-tin oxide coatings on glass substrates in a vacuum chamber (2), having a plasma source (12) located above said vacuum chamber and a substrate support (5) opposite said plasma source, and having a high-frequency source (8) connected to the substrate support (5), Cl_2 or Cl_2 and H_2 or CH_4 can be injected as an etching gas into the vacuum chamber (2), a process gas pressure of 0.1 to 10 µbar can be set and the high-frequency bias voltage supply (8, 9) of the substrate support (5) can be set independently of the etching particle density and the plasma source (12) is supplied by a separate high-frequency source (16), which has its own four-wire network (17).

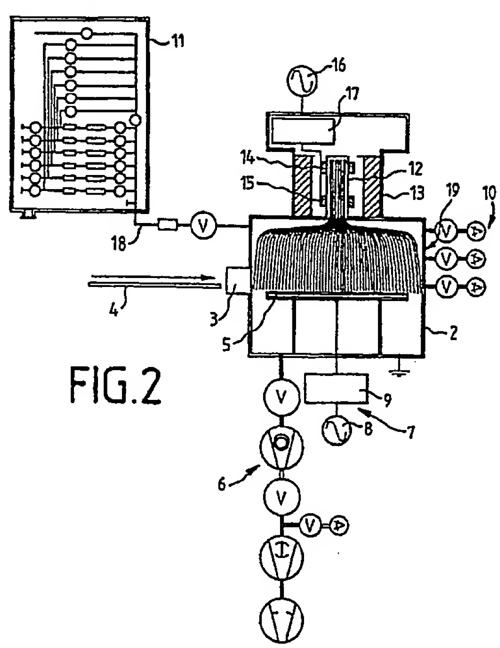

FIG.2

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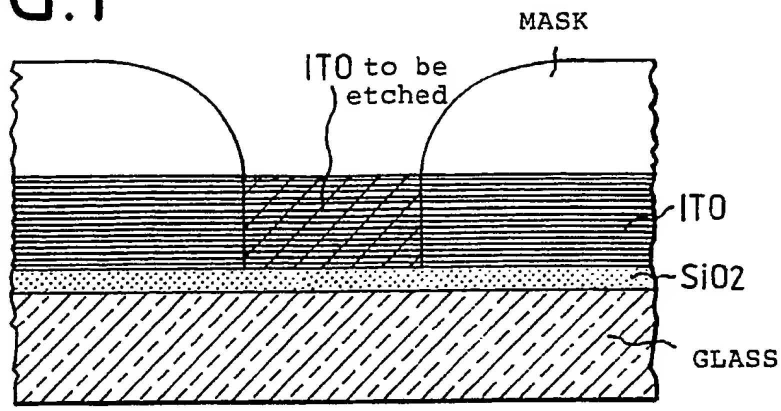
FIG.1


MASK
ITO to be etched
ITO
SiO2
GLASS

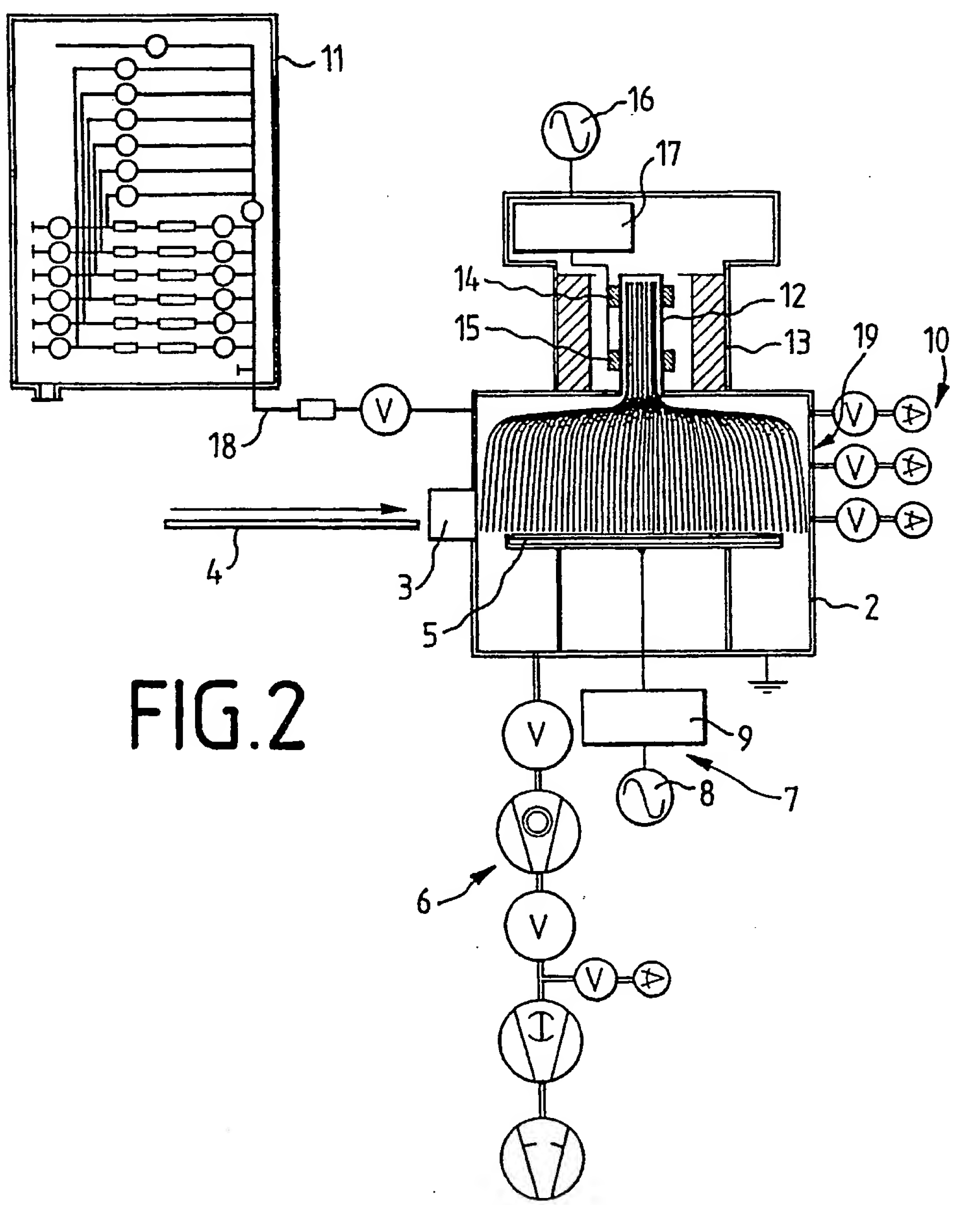

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FIG.2

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Process and apparatus for etching thin coatings, preferably indium-tin oxide coatings

The invention relates to a process and apparatus for etching thin coatings, preferably the etching of indium-tin oxide coatings on glass substrates in a vacuum chamber, with a plasma source disposed therein and a substrate support opposite said plasma source and with a high-frequency source connected to the substrate support.

The etching of indium-tin oxide coatings, known as ITO coatings, is carried out mainly in wet-chemical baths. The disadvantage in these processes is the environmental problem of disposing of the liquid chemicals produced, and of the isotropic etching behaviour and particle contamination due to etching residues left in the baths. In this case, dry etching processes do have advantages, since etching is carried out in a vacuum by reactive gases and by the acceleration of ionised gas particles towards the substrate. The ionisation of the gas may in this case be effected by a plasma.

Hitherto, parallel-plate reactor processes have been known for dry etching, but all these processes have the disadvantage that the etching particle density and types cannot be set independently of their kinetic energy.

Another problem in ITO etching is the different chemical reactivity of the components of ITO, namely indium, tin and their oxide compounds. In parallel-plate reactor processes (RIE processes), therefore, the reaction balance must rather be transposed to the physical reaction (sputter etching) by acceleration of the ions on to the substrates by high bias voltages (~ 500 V). This bombardment also leads to heavy etching of the substrate material and therefore to low selectivity. Therefore, carbon-containing gases or freons are used as etching gases, which are supposed to permit more homogeneous etching. This effect is achieved by a combination

of etching and passivisation, although this leads to low etching rates. Furthermore, only a very small processing window is achieved, as the operation is always being carried out at the sharp border between etching and passivisation. The carbon-containing freons are furthermore classed as environmentally harmful and the fluorine components additionally etch the substrate material, glass or SiO_2.

The object of the present invention is to create an etching process suitable for ITO, together with suitable apparatus, both of which permit high etching rates and are free of the above-mentioned disadvantages.

This object is achieved according to the invention if, as an etching gas, Cl_2 or Cl_2 and H_2 or CH_4 can be injected into the vacuum chamber and a process gas pressure of 0.1 to 10 μbar can be set, in which case the high-frequency bias voltage supply of the substrate support can be set independently of the etching particle density and a plasma source is provided which is supplied by a separate high-frequency source and has its own four-wire network.

The invention proposes etching with chlorine gas, wherein with a suitable ratio of ions, atoms, molecules and kinetic energies, both the requirements for residue-free etching and high selectivity to glass/SiO_2 are achievable. The separate adjustments of plasma density and particle energy necessary for this are made possible by the use of the plasma-source-supported etching process. Chlorine etches both indium and tin. By the addition of hydrogen or methane, the etching process can be further controlled by reducing the oxide compounds of indium and tin.

The use of powerful plasma sources permits low-pressure processes (0.1 ... 10 μbar) with Cl_2, Cl_2/H_2 or Cl_2/CH_4, whereby particle-free etching is possible, as is required for applications in display technology. Large-area etchings are

made possible by the use of a plurality of plasma sources and/or expansion of the plasma by magnetic confinement.

The use of source-supported processes has advantages, because the fragmentation and ionisation of the etching gases takes place in the plasma source, but the energy of the particles can be adjusted independently thereof by the HF bias on the substrate support. This is critical for the two etching requirements of homogeneous etching of ITO and selective etching to the underlying substrate material.

The invention admits of a wide variety of possible embodiments; one of these is shown in more detail in the attached drawings, in which:

Figure 1 shows a section through a glass substrate having an ITO coating and

Figure 2, a purely diagrammatic representation of the etching process.

The apparatus shown in Figure 2 essentially consists of the vacuum chamber 2 with the gate 3 for the supply and delivery of the substrate 4, the substrate support 5, the vacuum pump unit referenced 6 as a whole, the power supply 7 electrically connected to the substrate support 5 and incorporating a high-frequency generator 8 and a four-wire network 9, the inspection window 10 in the wall of the vacuum chamber 2 for observing the etching process, the gas box 11 with the metering devices for the process gas Cl_2, H_2 or CH_4, the plasma source 12, the ring magnets 13 surrounding the plasma source 12, the antennae 14, 15 and the high-frequency source 16 for the plasma source 12 with the four-wire network 17.

After the substrate 4 has entered the vacuum chamber 2, the chamber has been evacuated by means of the pump unit 6, and process gas from the gas box 11 has been introduced into the

vacuum chamber 2 via the gas feed 18, both the antennae 14, 15 of the plasma source 12 and the substrate support 5, which forms the etching anode, are supplied with electrical power via the two high-frequency sources 8, 16. The two HF mains parts are connected to respective four-wire networks, so that the plasma source can be set or adjusted separately for example.

List of individual parts

2	vacuum chamber
3	gate
4	substrate
5	substrate support, etching anode
6	vacuum pump unit
7	power supply
8	high-frequency generator
9	four-wire network
10	observation window
11	gas box
12	plasma source
13	ring magnet
14	antenna
15	antenna
16	high-frequency source
17	four-wire network
18	gas feed
19	magnetic confinement, is part of the vacuum chamber, see Figure 2

Claims

1. Apparatus for etching thin coatings, preferably indium-tin oxide coatings on glass substrates in a vacuum chamber (2), having a plasma source (12) located above said vacuum chamber and a substrate support (5) opposite said plasma source, and having a high-frequency source (8) connected to the substrate support (5), characterised in that as an etching gas, Cl_2 or Cl_2 and H_2 or CH_4 can be injected into the vacuum chamber (2) and a process gas pressure of 0.1 to 10 μbar can be set, in which case the high-frequency bias voltage supply (8) of the substrate support (5) can be set independently of the etching particle density and the plasma source (12) is supplied by a separate high-frequency source (16) and has its own four-wire network (17).

2. Apparatus according to claim 1, characterised in that the plasma source (12) is a high-frequency source, e.g. an ECR source or a capacitively coupled high-frequency source, e.g. a helical source.

3. Apparatus according to claims 1 and 2, characterised in that the plasma generation is effected from one or more plasma sources (12) and a magnetic bucket (19), which is part of the vacuum chamber, for expanding the plasma.

4. Process for etching thin coatings, preferably indium-tin oxide coatings on glass substrates in a vacuum chamber (2), having a plasma source (12) located above said vacuum chamber and a substrate support (5) opposite said plasma source, and having a high-frequency source connected to the substrate support (5), wherein in a first process step as an etching gas, Cl_2 or Cl_2 and H_2 or CH_4 is injected into the vacuum chamber (2) and a process gas pressure of 0.1 to 10 μbar is reached, and in a second process step the high-frequency bias voltage

supply (8) of the substrate support (5) can be set independently of the etching particle density wherein the plasma source (12) is supplied by a separate high-frequency source (16) which has its own four-wire network (17).

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Patents Act 1977 **Examiner's report to the Comptroller under Section 17** **(The Search report)**	Application number GB 9414908.5
Relevant Technical Fields (i) UK Cl (Ed.M) B6J (JP, JQA, JQB, JQC, JQD, JQX, JQY, JMX, JMY); H1D (DGQ); H1K (KLECA, KLECM, KLECX) (ii) Int Cl (Ed.5) C04B 41/53; H01J 37/32; H01L 31/18	Search Examiner R J MIRAMS Date of completion of Search 26 OCTOBER 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASES: WPI, CLAIMS	Documents considered relevant following a search in respect of Claims :- 1 to 4

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2233286 A (MAGUIRE) Whole document	1,4

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).